PEST MANAGEMENT ALLIANCE PROJECT
FINAL REPORT

A REDUCED-RISK PEST MANAGEMENT PROGRAM FOR WALNUTS – YEAR 4
(JANUARY 1, 2002-DECEMBER 31, 2002)

AGREEMENT NUMBER 00-0205S

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February 28, 2003

Prepared for the California Department of Pesticide Regulation

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ACKNOWLEDGEMENTS

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This report was submitted in fulfillment of DPR Agreement Number 00-0205S, A Reduced-Risk Pest Management Program for Walnuts, by the Walnut Marketing Board under the sponsorship of the California Department of Pesticide Regulation. Work was completed as of February 28, 2003.

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EXECUTIVE SUMMARY

The walnut PMA work continues with the broad based focus of continuing current efforts to develop and demonstrate reduced-risk management strategies on walnuts and to improve communication and cooperation among different groups involved in refining and implementing economical reduced-risk walnut production. The PMA project has evolved into a broader program than originally envisioned with individual researchers working closely with the PMA in the area of codling moth and blight. This research feeds directly into the PMA project by allowing the PMA project to better focus on testing and demonstration that are near term. Several factors have increased the prospects for development of reduced-risk practices for codling moth, which is the primary target for broad-spectrum insecticides in walnuts. These factors include the documentation of resistance to the most commonly used insecticides and the development of newer pheromone application technologies such as sprayable pheromone and puffers. This coupled with the development of new, more selective insecticides that can help provide control without disruption of naturally occurring biological control. The codling moth PMA project in 2002 was able to successfully demonstrate mating disruption of codling moth at the six sites with the use of sprayable pheromone. Since sprayable pheromone is much easier for walnut growers to apply, this will make it easier for the growers to incorporate it into their codling moth control programs. The PMA sites were also able to demonstrate the use of a new monitoring lure that catches both males and females and is a viable monitoring method in pheromone permeated orchards. Blight researchers have designed a blight model, Xanthocast, which the PMA has been able to field test for growers in designated demonstration sites. The PMA will continue to develop management techniques from research funded by the Walnut Marketing Board, using UC IPM monitoring programs refined by the walnut PMA, and outreach programs that will result in increased adoption of reduced-risk walnut programs to further reduce the use of pesticides in walnuts.

INTRODUCTION

The objective of the fourth year Walnut PMA was to focus on standardized treatments using reduced-risk techniques with an emphasis on economic success for the grower. By building from the positive responses from the first three years, we continued to implement reduced-risk practices coupled with educational outreach. To compliment the framework, there are seven objectives: (1) to build upon the teamwork between the University of California Cooperative Extension, BIOS, California DPR, University Researchers, Industry leaders, PCA's, and growers, (2) controlling codling moth using reduced-risk practices, (3) to develop reduced-risk practices to control walnut blight, (4) demonstrate the feasibility of cover crops, (5) monitor for additional pests, (6) show the economic impact of a reduced-risk program, and (7) show pesticide use history in commercial walnuts. The PMA is multi-faceted program that encompasses various technologies in order to assist the walnut industry to adopt reduced-risk strategies.

Objective 1: Continue to build upon the Walnut Pest Management Alliance Team for implementation of reduced-risk strategies and extend the information to growers.

The Walnut PMA Management Team is the drive behind the Walnut PMA. The Management Team is responsible for directing and implementing reduced-risk strategies as well as standardizing treatments. The Team incorporates the various stakeholders into the program and

seeks new ideas constantly. By meeting throughout the year to plan, coordinate, and share data and new ideas, the Management Team is able to work effectively and efficiently to ensure that the PMA gathers the most scientifically reliable and easy to interpret results across the state. Extending information is an important part of this project. A wide variety of information can be presented in one arena and growers and other interested parties are able to participate in the process.

Objective 2: Demonstrate IPM strategies to control codling moth, *Cydia pomonella.*

In 2002, there were six codling moth research sites from Fresno to Tehama County. All orchards were the Vina variety, which is known to be codling moth susceptible. The five treatments consisted of Suterra's CM-F (Checkmate) sprayable pheromone at 10 grams a.i./acre, 20g a.i./acre, and 30g a.i./acre, and 3-M's sprayable pheromone at one rate (most sites used 15grams a.i./acre, some used 20 grams a.i./acre) and the untreated control. All treatments were applied every 35 days, for a total of four sprays for the season, reduced from five sprays in 2001. Harvest damage data was also collected from the grower standard in the same orchard. The grower standard consisted of the growers normal farming practices which could include organophosphate and pyrethroid use. Treatments were approximately ten acres each with the exception of the Butte site, which had five-acre treatment blocks with 3-row buffers between each. Untreated control blocks were approximately one acre. Each orchard was monitored with traps weekly from biofix to harvest and the trap liners were changed as necessary. Each treatment block had at least three Trece Delta Traps each with a different lure. The traps were as follows: one trap hung low with the Trece L2 lure (1x), and two hung high in the canopy, one with Suterra's 10x Biolure, and one with Trece's new DA kairomone lure. Suterra donated the 10X Biolure and the CM-F sprayable pheromone, and 3-M donated their product as well. The lures were changed according to the manufacturer's instructions, about every 4 weeks for the 10X lure and 8 weeks for the L2 and DA lures.

Ten trees were selected in the center row of each treatment and monitored for damage assessment throughout the season. The overwintering generation was monitored by nut drop, recording the total number of codling moth damaged dropped nuts, and subsequent generations were monitored by canopy counts, recording the damage in 50 nuts low and 50 nuts high. The in-season damage monitoring is very important in pheromone-disrupted orchards because it allows the grower to apply a supplemental insecticide if the damage readings are high enough. In addition, canopy counts are a very reliable way to predict damage at harvest. The harvest evaluation was collected from the same ten trees, and consisted of a 100-nut harvest sample from each of the trees.

In addition, there were three satellite sites, two in San Joaquin County, and one in Yuba County. These sites field-tested alternative methods of applying pheromone products for mating disruption. One new method was to bundle many pheromone-laced twist ties and hang the bundles at a rate of 3.2 per acre, which saves much labor over the traditional 2-4 ties per tree. Also, several different products were applied by air, innovations supplied by Russ Stocker. Russ also applied *Trichogramma platneri* aerially, creating split plots with each pheromone treatment.

Objective 3: Demonstrate IPM strategies to control walnut blight, *Xanthomonas campestris*.

The PMA and University of California Farm Advisors conducted five trials to further field-test the Xanthocast walnut blight model and to evaluate it for ease of use by growers and researchers. There were a total of three treatments in the walnut blight trial: (1) a Manex and Copper treatment at 2% pistillate bloom, then sprays following the Xanthocast model, (2) the growers' standard practice, and (3) the untreated control with no sprays of Manex or Copper. These treatments were followed uniformly across the five sites and each location represents a replication for data analysis.

Objective 4: Demonstrate the impact of a replanted covercrop, a naturally reseeding cover crop, and native vegetation.

A cover crop planted four years ago in Yuba County was replanted in December 1999 to augment reseeding after an herbicide application prevented some of the planted species from reseeding in the middle of the rows. Sampling of plant species present in the PMA and grower standard was conducted in early May using four transects in each plot with 10 quadrats per transect. Each quadrat was 0.5 m by 0.5 m. The sampling was done on a presence/absence basis, recording only whether species were present, not the number of each. UC weed ecologist Anil Shrestha analyzed the data.

Objective 5: Monitor for additional walnut pests: mites, aphids, and walnut husk fly.

Secondary pest populations can increase due to the reduction of insecticide sprays in pheromone mating disruption blocks. Mites, aphids, and walnut husk fly, which are potentially economically threatening, were monitored throughout the season and were treated as needed in some orchards.

Walnut husk fly was monitored in each treatment block with baited traps. Flies were collected from the traps and taken back to the laboratory for further study. They were examined to determine sex, and female flies were further inspected to determine if they were gravid. If females with eggs (gravid) were found, then it was recommended that an application of malathion plus bait be made within 7 to 10 days.

Walnut aphid and dusky-veined aphid were monitored, recording the number per leaf of walnut aphid, and the using the presence/absence method for the dusky-veined aphid, as well as mummies of parasitized aphids. If there was an average of 15 or more walnut aphids per leaflet, and no mummies, then a treatment was recommended. If many mummies were observed, then parasites may control the aphid population. The treatment threshold for dusky-veined aphid is their presence on 10% or more of the sampled leaves. Before treating, predators were noted in order to ensure a treatment would be necessary.

Pacific mite, *Tetranychus pacificus*, two-spotted mite, *Tetranychus urticae*, and European red mite, *Panonychus ulmi*, sampling began in June and continued every other week until a treatment decision is made. After a treatment decision is made, sampling continued every other week. If predaceous mites or six-spotted thrips are present on at least half of the leaflets that have mites, then natural enemies will control the population. If mite populations do not build up by the

middle of August, then a treatment may not be warranted. The treatment thresholds for mites are:

- If an oranophosphate or pyrethroid will be applied and no predators are present, then treat at 10% infested leaflets.
- If an organophosphate or pyrethroid will be applied and predators are present on 10% infested leaflets, then treat at 20% infested leaflets.
- If no organophosphate or pyrethroid will be applied and no predators are present, then treat at 30% - 40% infested leaflets.
- If no organophosphate or pyrethroid will be applied and predators are present at 20% - 25%, then treat at 40% - 50% infested leaflets.

Objective 6: Assess the economic impact of a reduced-risk program as compared to conventional practices.

Accurate economic data was collected on all materials evaluated as well as whatever the grower used to control codling moth. Materials, rates of sprays, number of applications, and application costs were recorded. Many of these reduced-risk materials are not used as readily as conventional materials, so at this time, the cost of reduced-risk materials can be higher than they may be in the future. However, recording the costs gives us insight into total and comparative costs until products become more widely used and as application methods become refined.

Objective 7: Record pesticide use in commercial walnuts over a 10-year time period.

Data was compiled using the California Agricultural Statistical Service, Pesticide Use Reports from Department of Pesticide Regulation, and University of California IPM web site. This information is important in order to recognize pesticide use trends and can be used to determine how proactive growers can be in utilizing such reduced risk alternatives as Bacillus thuringiensis and tefenobucide.

RESULTS

Objective 1: Continue to build upon the Walnut Pest Management Alliance Team for implementation of reduced-risk strategies and extend the information to growers.

The Walnut Pest Management Alliance Team has been proactive in refining and demonstrating pheromone mating disruption in walnuts as well as and keeping the information moving from Farm Advisors, to field scouts, and to the end users including growers, and PCAs and BIOS projects. Continuing to publicize the success of reduced risk practices is the foundation for it to become more widely used. The PMA Management Team continues to lead the organization and research required for adoption of these new practices. A core group of the Walnut PMA Management Team met Jan 24, 2002 during the Walnut Research Meeting in Bodega Bay to make decisions about the treatments to be used in the upcoming year. The Management Team met once during the season, on July 24, 2002, in Yuba City to review and compare data collected and to plan field meetings or educational programs for fall 2002. The Management Team met twice in the fall to compare and analyze harvest results and to share ideas for the next season. On October 3, at UC Davis, the Team discussed the preliminary harvest results, then due to the high degree of complexity of pheromone-based mating disruption, met again on November 15 in

Yuba City to interpret the analysis of harvest results. These meetings were attended by the Management Team, which includes about 25 members.

Field meetings and workshops are some of the ways information is extended to growers, cooperators and interested allied industry. About 70 growers, PCAs and other interested parties attended a meeting September 6 sponsored by the walnut PMA in the southern San Joaquin Valley covering the activities of the Walnut PMA, including the results of a fourth year of codling moth mating disruption and the new bisexual lure for use in both conventional and mating disruption settings.

The results of this year's fieldwork were reported at the 35th Annual Walnut Research Conference in January 2003. An update on the Walnut PMA was presented at walnut commodity meetings sponsored by farm advisors in Tehama County on February 20, 2002, and in Sutter County on February 25.

Results from the 2002 season were reported in the Walnut Research Reports, 2003 "Walnut Pest Management Alliance 2002: Year 4 Update". This report is published and made available to all walnut growers. Articles were written about the Walnut PMA in the California Walnut Commission newsletter of June 2002. Specifically, "Walnut PMA Concludes Year 3 with Promising Results for Sprayable Pheromone" and "IPM Project Seeks to Expand the PMA's success with Sprayable Pheromone." The California Walnut Commission's Dec. 2002 report was sent with a stand-alone PMA newsletter inserted. Articles detailed the goals of the PMA, codling moth damage and mating disruption, blight forecasts, and the PMA's accomplishments and lessons learned. In all, this was the most detailed newsletter yet.

Walnut PMA outreach also included the codling moth website. Researchers at the six replicated (Tehama, Butte, Yuba, Tulare, and two in the northern San Joaquin region) walnut PMA sites entered their trap catch data to the UCD IPM website. Biofixes and spray dates for each site were also entered as the season progressed. The data is represented in graph form for each treatment block at each site, which can then be viewed and downloaded by all partners and growers in the project. To view the graphs, go to http://www.ipm.ucdavis.edu/PM/ and when prompted, enter the username, *WCMmem* and the password, *Vinamem*

Objective 2: Demonstrate IPM strategies to control codling moth, *Cydia pomonella*.

In 2002, the Walnut PMA consisted of six pheromone-based mating disruption research sites with standardized treatment blocks across the state. The six sites monitor different growing conditions across the state, as well as acting as replications for the treatments. In 2001, the PMA demonstrated codling moth control with the use of sprayable pheromone so in 2002 the trials focused on refining the application rates and procedures. The two products used were Suterra's Checkmate® and 3-M's flowable pheromone. The PMA also included three satellite trials to field-test other methods of delivery for the pheromone.

Harvest damage is used to determine how well each treatment worked, or in other words, how well each treatment controlled damage. Three of the sites supplemented the pheromone with either Lorsban or Confirm to reduce the economic risk to the grower. Table 2.1 shows the average percent damage by treatment for each site and each replicated treatment. Chart 2.1 depicts the average percent damage at harvest per replicated treatment. There was no statistical

difference between pheromone treatments, but the 10-gram/acre treatment was significantly different from the untreated check at the 5% level. Since the effectiveness of higher rates doesn't seem to be any better, lower rates can be used, making the program more economical and implementation easier.

Table 2.1. Damage at Harvest in each orchard and each replicated treatment in the Walnut PMA 2002.

% CM Damage

Site	**Suterra** Checkmate @10g/ac	**Suterra** Checkmate @20g/ac	**Suterra** Checkmate @30g/ac	**3-M *** Sprayable Pheromone	Untreated Check	Grower Standard
Yuba 1 [1]	1.2	2.1	2.1	1.5	1.2	0.9
Butte[2]	1.3	2.2	1.8	2.2	3	2.4
Tehama 1[3]	0.07	0.07	0.07	3.1	0.0	-
SJ 1	1.6	2.5	0.5	1.2	4.7	-
SJ 2	4.7	4.5	5.2	-	8.3	-
Tulare	0.0	0.0	0.0	0.0	0.2	0.0
Average	1.5	1.9	1.6	1.6	2.9	1.1
St. Dev.	1.71	1.69	1.97	1.16	3.19	1.21

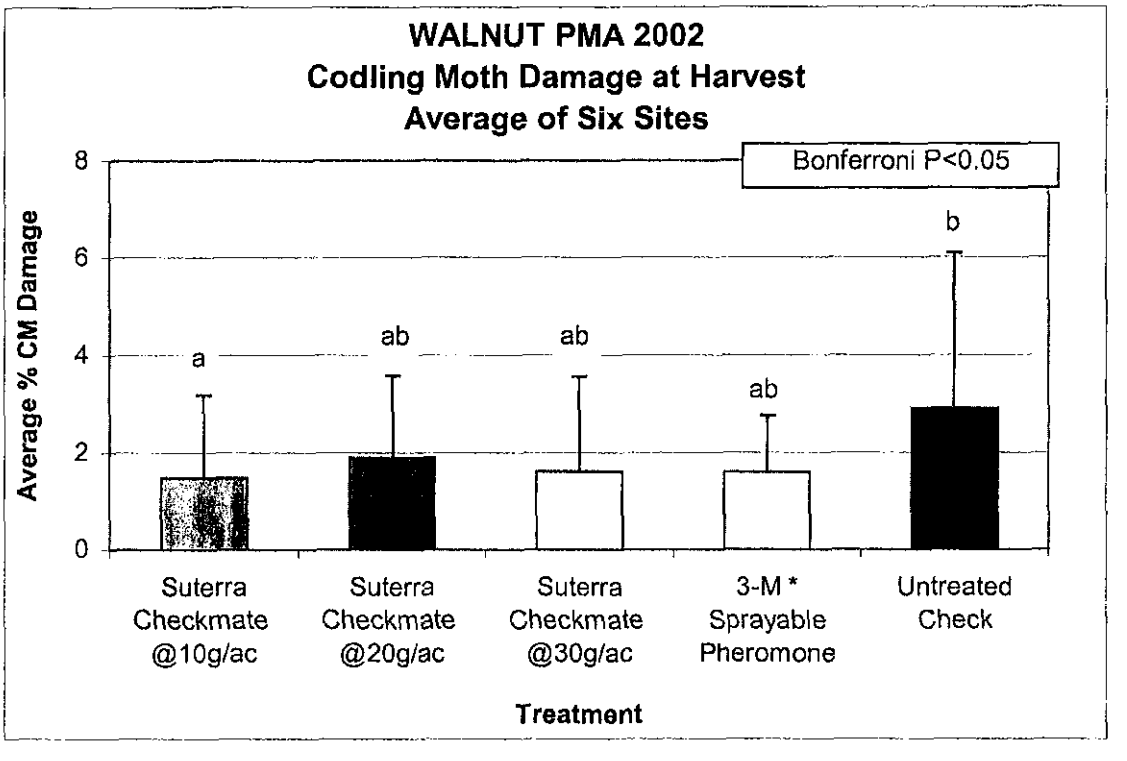
* 3-M product rates varied by site

[1] 10g, 20g, 3-M plots supplemented with Lorsban, 8/15/02

[2] 10g, 20g, 3-M plots supplemented with Lorsban, 8/8/02

[3] 10g and 20g plots supplemented with Confirm, 7/16/02

Chart 2.1. Average percent damage per treatment 2002



Three satellite trials researched the efficacy of different delivery methods for the pheromone products. Russ Stocker, of Arena Pest Management, provided aerial applications. Treatments included:

A. Suterra's Checkmate CM-F sprayable pheromone applied aerially by airplane.
B. Biocontrol's Isomate twist ties, hand applied in the upper 1/3 of the canopy.
C. Isomate twist ties, stapled to pairs of cardboard cards connected by strings, applied aerially, by helicopter (string and cards get tangled in upper branches and remain for season).
D. Hercon's pheromone "blotter paper", applied as above, by helicopter.
E. Isomate "Mops", devices that cluster enough twist ties for 1/3 acre into one holder.
F. Hercon "Mops", similar to above.
G. *Trichogramma platneri* applied aerially to plots of the above treatments, weekly during the third CM generation.

These sites were monitored and sampled in the same manner as the replicated plots, however the results will be reported separately, Tables 2.2 and 2.3.

Table 2.2 Harvest Damage (average of 10 trees) at Satellite Plots in San Joaquin County

	A-B *	**Locke**
Treatment	**% CM Damage**	
Isomate, hand applied	0	3.2
Isomate + Trichogramma platneri	0.8	1.8
Isomate Mop	0.5	2
Isomate Mop + Trichogramma platneri	0.3	2.2
Hercon Mop	1.5	-
Hercon Mop + Trichogramma platneri	1.2	-
Grower Standard	0.8	-

* Supplemented with Lorsban July 19, 2002

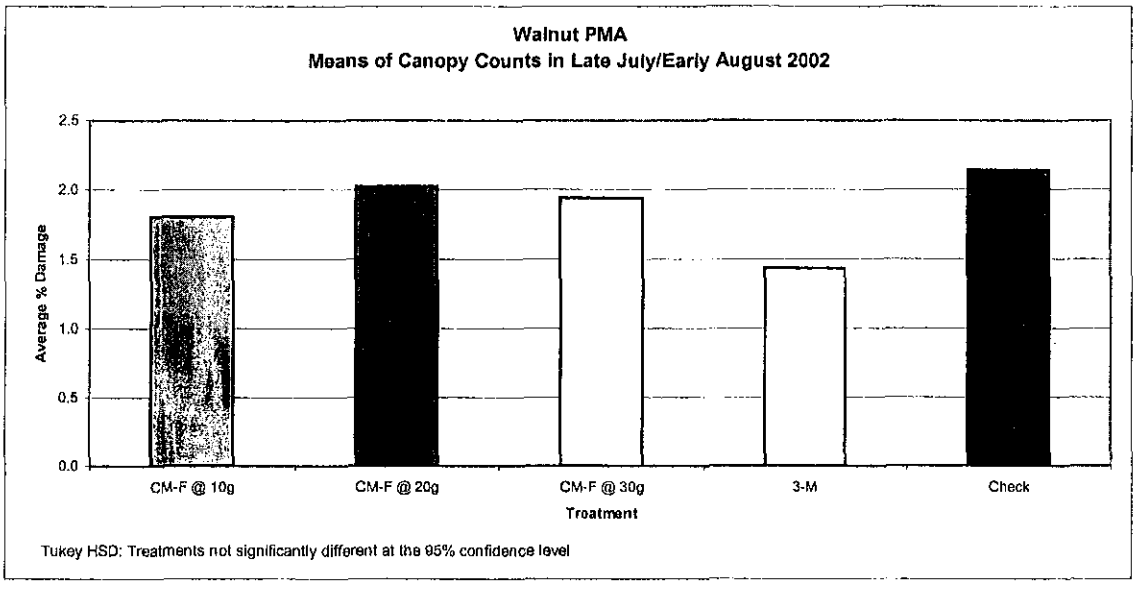
Table 2.3 Harvest Damage (average of 5 trees) at Satellite Plots in Yuba County

Treatment	**% CM Damage**
Aerial Checkmate	0.4
Aerial Checkmate + Trichogramma platneri	0.4
Aerial Isomate	1.4
Aerial Isomate + Trichogramma platneri	1.1
Isomate Mops	3.2
Isomate Mops + Trichogramma platneri	1.8
Isomate, hand applied	0.4
Isomate + Trichogramma platneri	1.8
Aerial Hercon	1.2
Aerial Hercon + Trichogramma platneri	2.6
Grower Standard	1.2
Untreated Check	1.0

Monitoring techniques such as nut drop and canopy counts are tools to aid in determining damage levels at the end of each respective generation and the canopy counts have been good indicators of damage at harvest. Nut drop data is an analysis of the amount of damage from the first generation of codling moth. Each orchard monitored the codling moth infested walnuts that dropped off the tree in the overwintering generation or first flight. In each treatment, five trees were selected in the center of the block and marked for use over the entire season. Weekly, the walnuts under each of these five trees were inspected for codling moth damage.

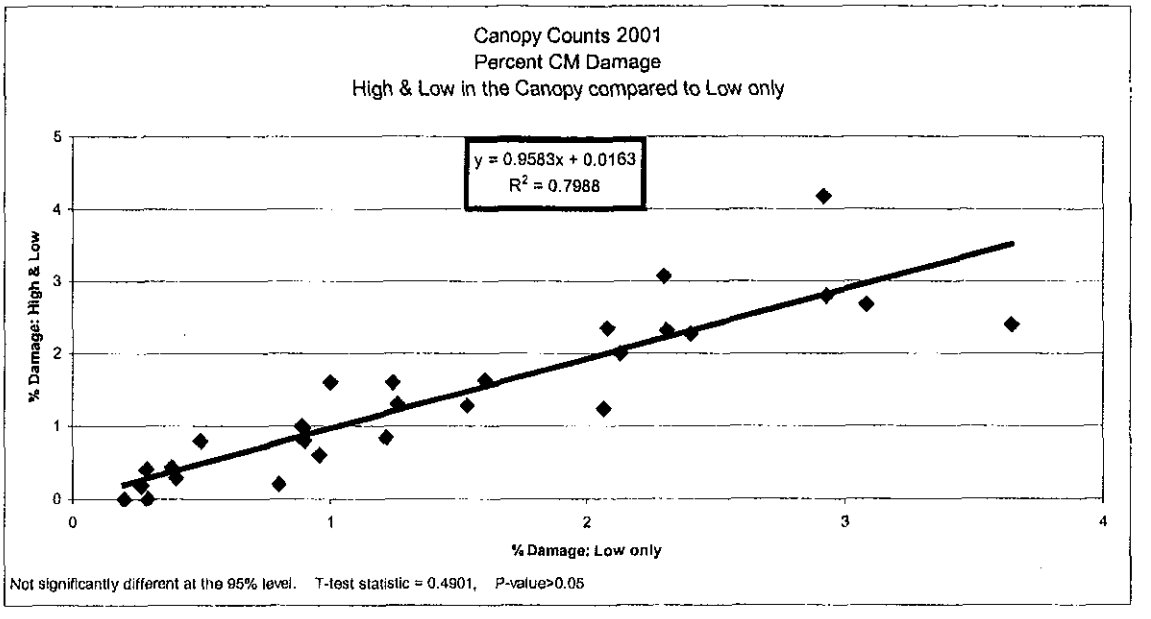
Further indication of no difference between pheromone treatments (harvest sample data shows this also) regardless of supplementation with an insecticide is the data collected in the second canopy count. This second canopy count was performed in late July or early August before any insecticide was applied. Chart 2.2 shows the average of 5 sites' canopy count data. Data from the Tulare site was not included because there was no damage found in any treatment in the canopy counts.

Chart 2.2 Percent CM Damage in Second Canopy Count, Average of 5 Sites



Canopy counts were conducted in all six walnut PMA orchards using the same five trees chosen for nut drop. At the end of the overwintering generation, walnuts in the tree were inspected for codling moth damage. At each tree, 50 walnuts were randomly inspected low in the canopy and 50 walnuts were randomly inspected high in the canopy using orchard ladders for a total of 100 walnuts per tree, 500 walnuts per treatment. Canopy counts were conducted again at the end of the second codling moth generation, Canopy Count 2. They were conducted in the same manner, inspecting walnuts low in the canopy and high in the canopy, using the same trees as for nut drop and the first canopy counts. Damage to nuts found in canopy counts is commonly used to determine the need for treatment with an insecticide. In a commercial orchard, however, it is not usually feasible to use a ladder to look at lots of nuts high in the canopy. We found that statistically data gathered by inspecting nuts only low in the canopy without the use of ladders is not significantly different from the 'high and low' method, Chart 2.3, and could be equally valuable in determining percent damage with reduced time and effort.

Chart 2.3 Percent CM Damage in Canopy Counts. High and Low in the Canopy Compared to Low Only.



The data shows that there is may be no need to use ladders, which would greatly reduce the time and effort needed for canopy counts. This hypothesis needs more study; the two methods will be compared in year 5 of the Walnut PMA.

Objective 3: Demonstrate IPM strategies to control walnut blight, *Xanthomonas campestris*.

The Walnut PMA in 2002 conducted walnut blight trials at five sites, three in the San Joaquin Valley and two in the Sacramento Valley. The three treatments were (1) conventional Copper/Manex applications, the growers standard program, compared to (2) Copper/Manex applications at 2% pistillate bloom, then following the Xanthocast blight model, and (3) untreated check was also included. The Xanthocast model's prediction of disease pressure ("blight index") is calculated using climatic readings from each of 50 weather stations in the north state, and was made available for no cost on the website www.Fieldwise.com. The blight index was checked daily by researchers to see if it had reached the threshold for spray treatment at the weather station nearest to the orchard. This information was passed to the cooperating growers who treated the corresponding blocks as indicated by the model. The treatments were followed uniformly across the four sites and each location represents a replication for data analysis.

Blight surveys were conducted in the participating orchards in June. One thousand nuts per treatment were visually inspected for symptoms of blight infection in the canopy. The results from the various treatments can be seen in Table 3.1. The values are expressed in percent walnut blight. With very little walnut blight present, few conclusions can be drawn from this year's trial. The treatments did not have a statistically significant effect on blight at the 95% confidence level, the P-value = 0.166. The statistics do not include the SJP site since no nuts with blight symptoms were found. To adequately evaluate these treatments more severe walnut blight conditions need to occur.

Table 3.1 Percent walnut blight Walnut PMA 2002

Treatment Timing	Butte	Yuba	SJ P	SJ D	SJ B	Mean
Untreated Control	0	1	0	16.5	3.2	4.14
Grower Standard	0	0.5	0	8.7	0.7	1.98
Pistillate flower + Xanthocast Model	0.2	0.1	0	10.5	0.5	2.26

Objective 4: Demonstrate the impact of a replanted covercrop, a naturally reseeding cover crop, and native vegetation.

A cover crop planted four years ago in Yuba County was replanted in December 1999 to augment reseeding after a herbicide application prevented some of the planted species from reseeding in the middle of the rows. Sampling of plant species present in the PMA and grower standard was conducted using four transects in each plot with 10 quadrants per transect. Each quadrant was a nested quadrant with dimensions of 0.25 m by 0.25 m and 0.5 m by 0.5 m plot. The sampling was done on a presence/absence basis, recording only whether species were present, not the number of each. UC weed ecologist Anil Shrestha analyzed the data.

The weed species were surveyed in early May. Of the species originally planted in the PMA blocks, the blando brome and the sub clover populations increased, and the medic population remained the same. Pink nitro, crimson clover, and vetch did not establish as well, as their numbers were decreasing. The species present at the site are summarized in Table 4.1 below.

Table 4.1. Plant species present at the Yuba County Site

GROWER STANDARD	plant category	PMA	plant category
blando brome	F	blando brome	F
burr clover	F	Crimson clover	F
White sub clover	F	Medic	F
foxtail barley	SW	pink nitro	F
Geranium	SW	Vetch	F
Horse weed	SW	white sub clover	F
Ranunculus	SW	Carolina geranium	SW
sow thistle	SW	Dock	SW
willowweed	SW	foxtail barley	SW
annual blue grass	WW	ranunculus	SW
Chickweed	WW	sow thistle	SW
Fillaree	WW	annual blue grass	WW
miner's lettuce	WW	chickweed	WW
ripgut brome	WW	Fillaree	WW
Speedwell	WW	groundsel (senecio)	WW
		Persian speedwell	WW
		ripgut brome	WW
		scarlet pimpernel	WW

Plant category: F = forage (planted), WW= fall or winter weed, SW = spring or summer weed.

Objective 5: Monitor for additional walnut pests: mites, aphids, and walnut husk fly.

Walnut Husk Fly

Three of the six statewide orchards monitored for walnut husk fly by PMA researchers. These sites were Yuba, Butte, and Tehama counties, as they have a history of walnut husk fly. Traps were placed in mid-June at the Tehama site and early July at Butte and Yuba. A trap with ammonium carbonate bait was placed in each treatment block and checked weekly or twice weekly for females with eggs. The Tehama site required full treatments for walnut husk fly on July 25 and spot treatment in the untreated control on August 31. One of the San Joaquin sites, SJ 2, was monitored by a private PCA and was spot treated around the perimeter and the center middles on August 20. At the Yuba site, the number of mated females was starting to increase a week before harvest, and the grower opted not to treat. The other sites did not treat for walnut husk fly.

Aphids

Starting mid-June, aphids were monitored every other week. Fifty leaves were examined from each treatment block, 5 leaves each from 10 trees. Walnut aphids were usually present as were walnut aphid mummies. The treatment threshold of 15 per leaf was never reached, and the numbers of mummies were usually at least half of the numbers of live aphids. This shows that the aphid parasites were controlling the populations. Dusky-veined aphid colonies were rarely seen. Beneficials, such as six spotted thrips, lacewing larvae, and ladybug larvae were always found in numbers of one to fifteen per treatment block. No orchard required a specific aphid treatment

Webspinning Mites, European Red Mites, and Western Predatory Mite

Webspinning, European red, and western predatory mites were monitored every other week, in rotation with the aphid monitoring. Again fifty leaves were collected, five low and five high in the canopy of 10 trees. Webspinning and European Red mites were not always present, but beneficials such as six-spotted thrips and lacewing larvae were always found. Predatory mites were found whenever webspinners were present. Mite monitoring began in all orchards in July. Populations of webspinning mite and predatory mites were recorded as present or absent on leaves. Treatment decisions were based on the percentage of leaves infested, however, a treatment may not be necessary if half of the leaves with webspinners have beneficials or predatory mites. The Tulare site reached 98% of leaves with webspinning mites on July 14, and only 4% of the leaves had predatory mites. The orchard was treated with AgriMek on July 22, after that no mites were present. The San Joaquin-1 site was monitored by a private PCA, and was treated with Omite. None of the other sites were treated for mites.

Objective 6: Assess the economic impact of a reduced-risk program as compared to conventional practices.

For each of the six orchards, the reduced risk treatment costs were the same. However, three of the sites had a supplemental Lorsban or Confirm treatment for codling moth control that added to the cost. When a supplemental insecticide was used for codling moth control, it was applied to the Suterra CM-F 10 gram, CM-F 20 gram, and 3-M treatment blocks. No supplemental sprays were applied to the CM-F 30-gram blocks. The pheromone was applied four times at 35-day intervals at all sites beginning just after biofix, or shortly thereafter, when the trees began to leaf out. The Suterra product was used with the recommended sticker-spreader, NuFilm-P at 6 oz per acre. The 3-M product had nothing added. Both companies donated the pheromone for this project. The retail prices for the pheromone products was quoted by representatives of each respective company as follows in Table 6.1:

Table 6.1 Walnut PMA 2002 Costs per Acre of **Materials** only

PRODUCT	RATE /ACRE	COST /ACRE
Suterra CM-F	10 grams	$ 20
Suterra CM-F	20 grams	$ 40
Suterra CM-F	30 grams	$ 60
3-M	15 grams	$ 35
3-M	20 grams	$ 42
NuFilm-P	6 ounces	$ 0.70
Lorsban	4 pints	$ 22
Confirm	1 pint	$ 22

The treatments were all applied with an airblast orchard sprayer. The typical hourly pay for skilled labor to use the sprayer is $9 per hour. With the addition of payroll taxes and insurance, the cost to the grower is $12.06 per hour. The total cost per acre to use the sprayer is $15.57, which includes labor, fuel, lube, and repair. These costs were taken from "UC Extension Sample Costs to Establish a Walnut Orchard and Produce Walnuts, 2002". Table 6.2 below, shows the TOTAL costs per acre for all of the treatments used.

Table 6.2 Walnut PMA 2002 **Total** Costs per Acre for CM Mating Disruption

MATERIAL	RATE	MATERIAL $/AC	APPLICATION $/AC	EACH $/AC	# OF SPRAYS	SUB TOTAL	**TOTAL**
CM-F + NuFilm-P	10 g 6 oz	$20 $0.70	$15.57 $0	$36.27	4	$145.08	**$145.08**
CM-F + NuFilm-P	20 g 6 oz	$40 $0.70	$15.57 $0	$56.27	4	$225.08	**$225.08**
CM-F + NuFilm-P	30 g 6 oz	$60 $0.70	$15.57 $0	$76.27	4	$305.08	**$305.08**
CM-F + NuFilm-P Lorsban/ Confirm	10 g 6 oz 4 pt/ 1 pt	$20 $0.70 $22	$15.57 $0 $15.57	$36.27 $37.57	4 1	$145.08 $37.57	**$182.65**
CM-F + NuFilm-P Lorsban/ Confirm	20 g 6 oz 4 pt/ 1 pt	$40 $0.70 $22	$15.57 $0 $15.57	$56.27 $37.57	4 1	$225.08 $37.57	**$262.65**
3-M	15 g	$35	$15.57	$50.57	4	$202.28	**$202.28**
3-M	20 g	$42	$15.57	$57.57	4	$230.28	**$230.28**
3-M Lorsban/Confirm	15 g 4 pt/ 1 pt	$35 $22	$15.57 $15.57	$50.57 $37.57	4 1	$202.28 $37.57	**$239.85**

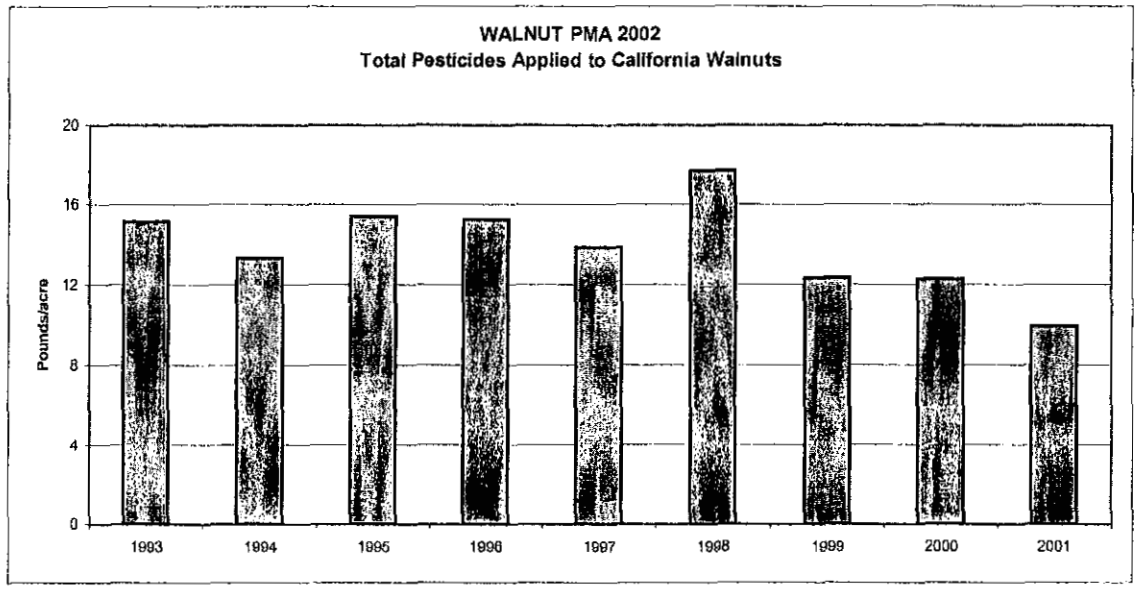
There were a wide variety of grower standard treatments. Not all the sites included a grower standard comparison treatment. For comparison, the 2002 UC Walnut Cost Study lists the costs for codling moth control at $87 per acre.

The cost of some mating disruption products may change as the products become more widely used.

Objective 7: Record pesticide use in commercial walnuts over a 10-year-time period.

The results presented in this section were acquired from the world wide web sites of the California Agricultural Statistical Service, www.nass.usda.gov/ca, and the California Department of Pesticide Regulation Pesticide use Reports www.cdpr.ca.gov/docs/pur. Walnut acreage has fluctuated over the last eleven years, resulting in a slow but steady increase. Due to the fluctuation in the number of acres, applications to California walnuts are all summarized here as pounds per acre. Pesticide use in walnuts has been on the decline, 2001 being the lowest use yet with total pesticide use at 9.97 pounds/acre, Chart 7.1. Organophosphates, pyrethroids, carbamates, and *Bacillus thuringiensis* are also summarized separately in this section.

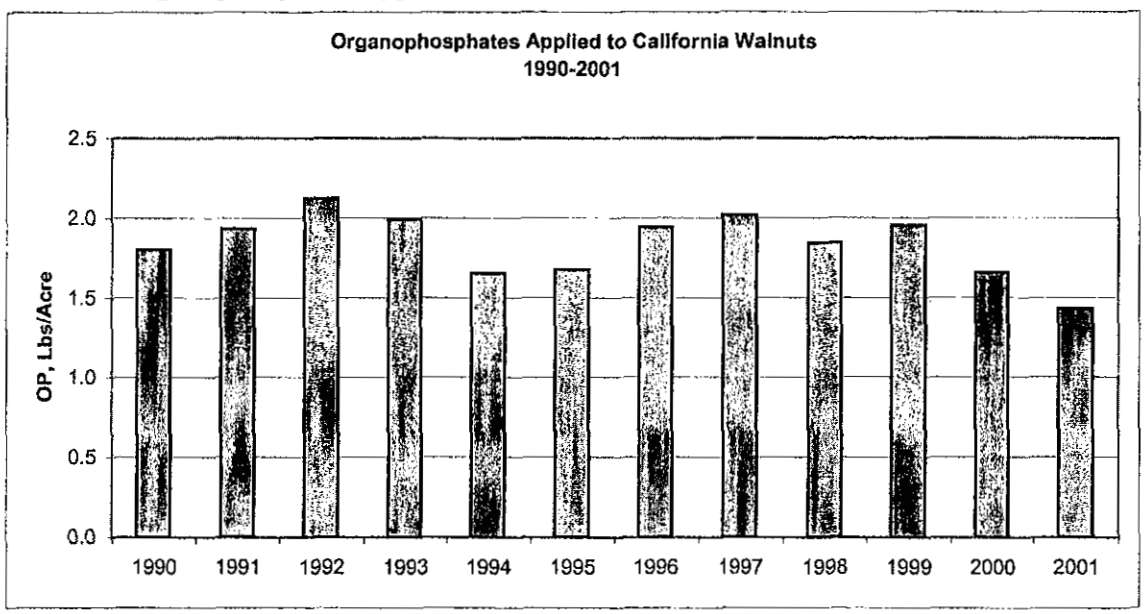
Chart 7.1 Total Pesticides Applied to California Walnuts



Organophosphate

The organophosphates used to determine the following were: azinphos-methyl, chlorpyrifos, diazinon, malathion, methidathion, methyl parathion, naled, oxydemeton-methyl, phosalone, phosmet, phosphamidon, and phosphamidon related products. Statewide applications over the last eleven years are shown in Chart 7.2, below. The year 2001 had the lowest amount of organophosphates applied since 1990. Growers applying these products are doing so because of the potential for economic loss due to codling moth. Organophosphates are cholinesterase inhibitors, one of the most toxic classes of pesticides, and are of high regulatory concern.

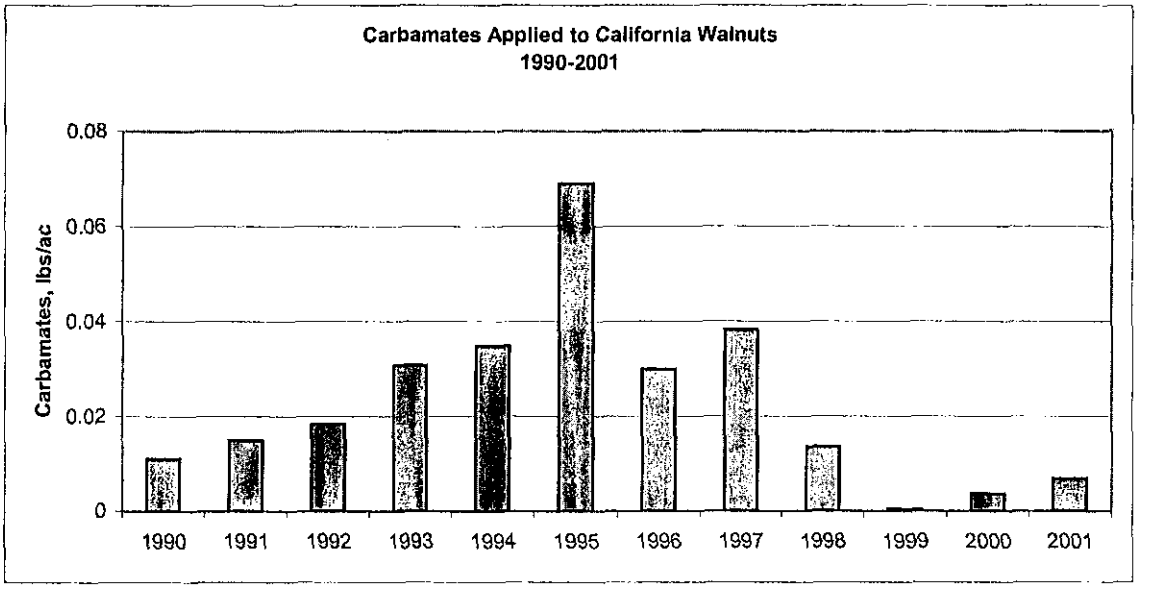
Chart 7.2 Organophosphates applied to California Walnuts, pounds per acre



Carbamates

The carbamates evaluated for this report are carbaryl and methomyl. Carbamates are also cholinesterase inhibitors, affecting the central nervous system. Carbamate use is at a very low point since peak use in 1995, and 2001 shows the third lowest level of use in 12 years, Chart 7.3.

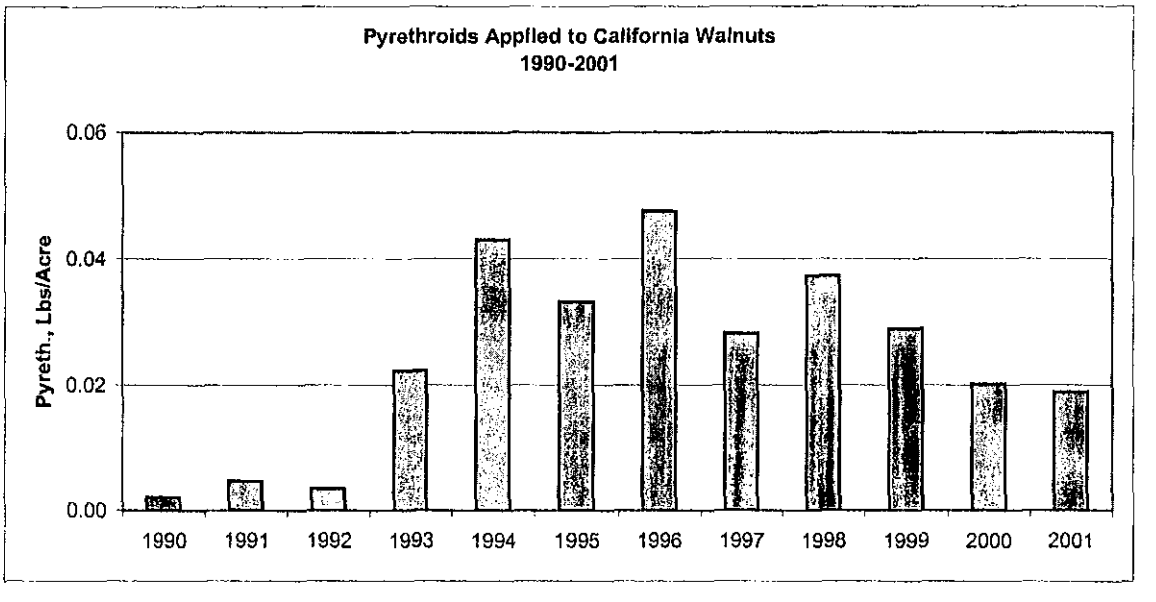
Chart 7.3 Carbamates Applied to California Walnuts, pounds per acre



Pyrethroid

Esfenvalerate and permethrin were the materials included in this summary. Statewide applications are shown in Chart 7.4. Pyrethroids are used throughout the growing season for several pests. The amount of pyrethroids used in California walnuts has been on a slow decline since peak use in 1996.

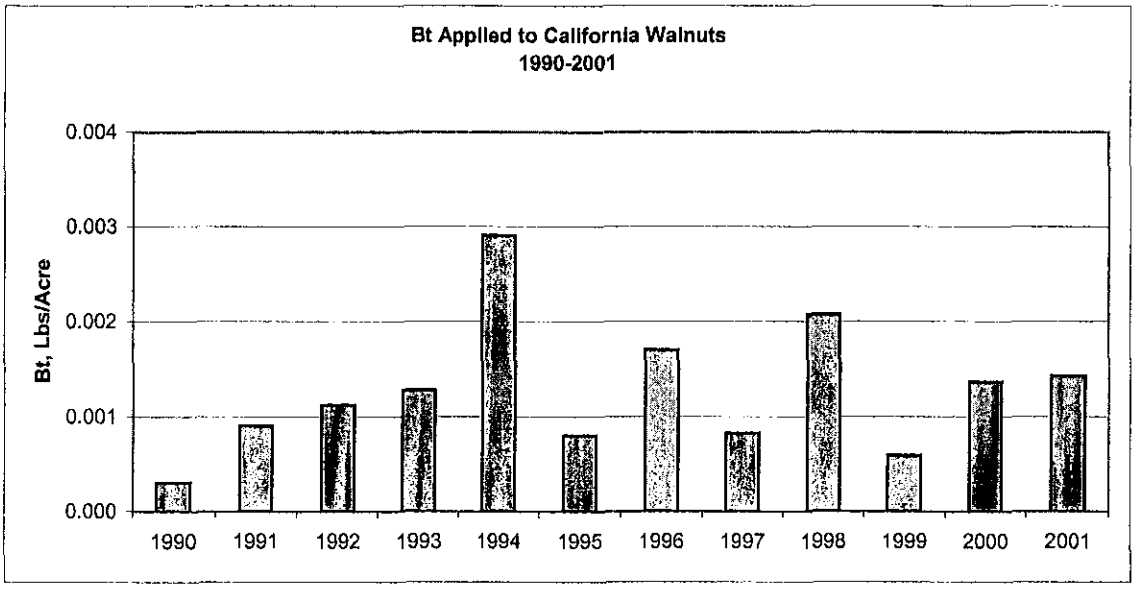
Chart 7.4 Pyrethroids Applied to California Walnuts, pounds per acre



Bacillus thuringiensis(Bt)

In the Early 1990's, there was very little use of Bt. In 1994, there was a large increase in pounds per acre applied. Since then, Bt use seems to rise and fall in alternating years, but without reaching the peak usage of 1994, Chart 7.5.

Chart 7.5 Bt Applied to California Walnuts, pounds per acre



DISCUSSION

The walnut PMA has maintained a strong alliance between the industry, UC researchers, UC Farm Advisors, BIOS partners, grower cooperators and PCAs. This year, the PMA narrowed its' focus to the pheromone mating disruption technology that will fit most easily into growers' current spray programs. The sprayable formulations are also more economical, therefore more likely to be adopted by walnut growers. Now that the alliance has developed and demonstrated reduced-risk practices, we can reach more growers by increasing the number of field trials. The alliance has been instrumental in serving as a communication body between all groups interested in reducing the reliance of pesticides in walnuts. It has helped direct and attract research funded by the walnut board that is directly relevant to the needs of developing economic reduced risk practices for growers. The Farm advisors and BIOS project managers have been able to participate and keep abreast of the reduced-risk practices which they can quickly extend to their local BIOS and extension programs. The walnut PMA has been able to attract additional researchers to the project since its inception. These include Dr. Steve Welter and Dr. Doug Light. The data collected by the PMA and extended to the walnut industry is an information base from which parallel projects can move into an implementation phase. The added visibility of these additional projects greatly enhances the adoption of pheromone mating confusion by even more growers, thereby reducing insecticide sprays. The Center for Agricultural Partnerships Walnut Expansion project in 2002 had cooperators in the same growing regions and trained PCAs to conduct the demonstration and the monitoring. The Nature Conservancy conducted field trials on more than 1,000 acres of environmentally sensitive land, allowing the grower to control codling moth while still maintaining reduced risk methods. These projects are an important step, including the PCAs who will be the ultimate end user, and ensuring adoption

of pheromone confusion with successful demonstrations. At the same time, they will be learning how to monitor the effectiveness of mating disruption so there is little risk to the grower.

The walnut PMA has been able to reach their goals of incrementally demonstrating a successful mating disruption program and to see emerging application technologies become commercially available that will be much easier for walnut growers to use such as the sprayable formulations. In 2002, the PMA focused on making the use of these sprayable pheromones more economical by reducing the number of applications and testing rates. We have also been able to develop effective monitoring protocols and are continuing work on how to best make use of the kairomone lure, which became commercially available in 2002.

The walnut blight demonstration program has moved along faster than originally planned with the Xanthocast Model becoming available to Sacramento Valley growers through Fieldwise.com and funded by Griffin LLC. In 2002, the PMA had four walnut blight trials across the state to evaluate the Xanthocast model The PMA also worked more closely with growers to learn to interpret the model more specifically for their situation. However, for the third year, the low incidence of rainfall resulted in low walnut blight damage with no significant differences between treatments. Results look promising for growers to have a tool to help them reduce the number of applications for walnut blight control.

The cover crop trial continued in Yuba County for its fourth year in 2002. Results have shown that planting a winter annual self-reseeding plot helped reduce winter weed problems, other trials have shown that it has increased water infiltration and decreased pesticide run-off. The recent addition of Anil Shrestha, weed ecologist at Kearny Ag Center, will help ensure that the PMA interprets the cover crop data correctly and doesn't overlook any of the meaning behind the data.

PROJECT SUMMARY FORM 2002

1) Proposal Title
A Reduced-Risk Management Program for Walnuts

2) Principal Investigator
Dennis Balint, Walnut Marketing Board

3) Alternative Practices
Pheromone mating disprution to control codling moth applied aerially and with sprayer, vegetation management (i.e. cover crops) to suppress winter weeds, prevent erosion, prevent pesticide runoff, improve water filtration, and increase biodiversity. Disease forecasting and other IPM strategies to control walnut blight.

4) Summary of Project Successes:
Mating disruption materials have been shown to provide effective control of codling moth statewide, including the sprayable formulation. Replicated treatments statewide allow statistical analysis of results. PMA has built a positive relationship with growers who allowed unsprayed contols in their commercial orchards. Research has developed and demonstrated a walnut blight forecast model.

5) Number of Participating Growers: 9

6) Total Acreage in Project: 340

7) Project Acreage Under Reduced Risk: 327

8) Total Acres of Project Crop: Unknown

9) Non-Project Reduced Risk Acres: Unknown

10) Number of Participating PCAs: 9

11) Cost Assessment: Total costs: (includes material, equipment and labor). Covers sprayable pheromone from 2 companies, at 4 rates, with and without supplemental insecticide.

MATERIAL	RATE	# OF SPRAYS	SUB TOTAL	**TOTAL**
CM-F + NuFilm-P	10 g 6 oz	4	$145.08	**$145.08**
CM-F + NuFilm-P	20 g 6 oz	4	$225.08	**$225.08**
CM-F + NuFilm-P	30 g 6 oz	4	$305.08	**$305.08**
CM-F + NuFilm-P Lorsban/ Confirm	10 g 6 oz 4 pt/ 1 pt	4 1	$145.08 $37.57	**$182.65**
CM-F + NuFilm-P Lorsban/ Confirm	20 g 6 oz 4 pt/ 1 pt	4 1	$225.08 $37.57	**$262.65**
3-M	15 g	4	$202.28	**$202.28**
3-M	20 g	4	$230.28	**$230.28**
3-M Lorsban/Confirm	15 g 4 pt/ 1 pt	4 1	$202.28 $37.57	**$239.85**

12) Number of Field Days: 1

13) Attendance at Field Days: 70

14) Number of Workshops & Meetings: 6

15) Workshop Attendance: 315

16) Number of Newsletters: 2

17) Number of Articles: 4

18) Number of Presentations: 3
Walnut Research Conf., Walnut Day in Tehama & Sutter

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APPENDIX A

WALNUT PMA MANAGEMENT TEAM MEETING AGENDAS (JULY 24, OCTOBER 3, AND NOVEMBER 15, 2002) AND TULARE COUNTY GROWER MEETING PROGRAM (SEPTEMBER 6, 2002).

WALNUT PMA AGENDA

July 24, 2002

9:30 AM to 1:30 PM

Introductions

Blight Report – Bill Olson and Rick Buchner

Codling Moth

- Codling Moth website – Sara Goldman Smith
- Research Status – Steve Welter
- Review PMA Sites Data – Carolyn Pickel
- Discussion of results for 2002

Plan 2002 Field Meetings – Carolyn Pickel

Reports from Expansion projects –

- Pat Weddle
- Fred Thomas

PMA Meeting October 3, 2002

DA – Kairomone-based Monitoring of Codling Moth Populations and Damage

The following monitoring and damage correlation analysis is desired and should be discussed:

Data Needed for each PMA Orchard test:

1) Excel Spreadsheet of pheromone and DA trap capture data and sexing.
2) Damage assessment data and Dates of assessment.
3) And the following Monitoring and Damage Correlation Plot/Figures.

CM Population Seasonal Monitoring, the standard comparative plots from March to trap take down (Sept. – October),

1) DA CM capture vs. Pheromone male CM capture,

2) DA Female vs. Male capture,

3) % Females mated, or numbers of mated vs. unmated females captured.

Prediction of CM Damage, Correlation of DA Capture and Damage Indexes,

Plot Regression of DA Capture vs. Damage Assessments:

Factors to Compare:

1) Accumulative number of CM (sexes combined) captured with DA,
2) Accumulative number of Males captured with DA,
3) Accumulative number of Females captured with DA,

vs.

1) Dropped Nut Counts,
2) Canopy Counts,
3) Harvest CM Damage.

Comparison Period:

1) For the immediate flight period prior to the damage assessment,
2) For all flight periods up to the damage assessment,
3) For the season up to the damage assessment.

Plot accumulative numbers of CM caught up to the date of that damage assessment, e.g.,

1) the numbers caught in the first flight up to the date of drop-nut counts,
2) the numbers caught in the beginning of the season (the first and second flights combined) up to the date of a canopy count,
3) the numbers caught over the entire season up to the date of Harvest collection.

Walnut PMA Management Team
11/15/02

Introductions

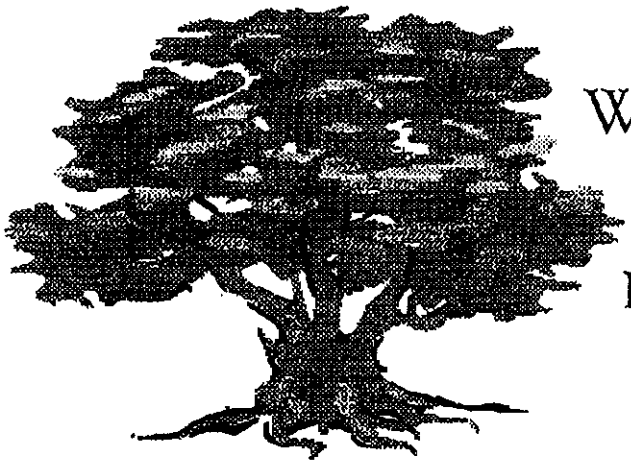
PMA Status

Results of Blight Forecasting - Carla Thomas

Results of Codling Moth Demonstration Sites – Carolyn Pickel and Steve Welter

Implementation Program Results
- Pat Weddle – CAP
- Fred Thomas – TNC
- Molly Johnson – BIOS Stanislaus

Future Plans



Tulare County Walnut Pest Management Alliance Program

Friday, September 6, 2002

UC Cooperative Extension Office
4437 S. Laspina Street #B, Tulare

AGENDA

8:30-9:00 a.m. Registration

Moderators:	**Walt Bentley**, IPM Entomologist, UC Kearney Agricultural Center and **Kevin Day**, UCCE Horticulturalist, Tulare County
9:00 a.m.	**Robert Elliott, Environmental Research Scientist CDPR and Dave Ramos, Research Director California Walnut Advisory Board** Objectives of the Walnut Pest Management Alliance
9:15 a.m.	**Joe Grant, UCCE Farm Advisor, San Joaquin County** Mating Disruption of Codling Moth: What Are the Choices?
9:45 a.m.	**Judy Stewart Leslie, Pest Management Associates, Exeter** Update on Center for Agricultural Partnerships (CAP) Program in Tulare County
10:05 a.m.	**Break**
10:15 a.m.	**Carolyn Pickel, Regional IPM Advisor, UCCE Sutter/Yuba Counties** Results of the 2001 Codling Moth Management Program Within the PMA Program
10:45 a.m.	**Doug Light, Entomologist, USDA** A New Codling Moth Lure For Use in Mating Disruption Orchards
11:30 a.m.	**Walter Bentley, IPM Entomologist, UC Kearney Agricultural Center** Are There Ways to Predict Codling Moth Damage Prior to Harvest?

Reservations Are Not Required

For Additional Information Contact:
Walt Bentley, Phone: 559-646-6527 or E-mail: walt@uckac.edu

APPENDIX B

CALIFORNIA WALNUT COMMISSION NEWSLETTERS: SUMMER REPORT-JUNE, FALL REPORT-DECEMBER, 2002.

CALIFORNIA WALNUT COMMISSION

SUMMER REPORT

2001-2002 June 2002

Walnut Industry Takes Part in "Consumer Food Choices Summit"

In 1995, the walnut industry first partnered with the *"Oldways Preservation & Exchange Trust"*, an organization based in Boston, Massachusetts. Their mission is promoting traditional diets, which over time have proven to be healthy, lowering the risk of chronic diseases such as cardio vascular disease. The first conference in which the California Walnut Commission was involved was as a partnership with the International Tree Nut Council (INC) and the response from the attending members of the press was outstanding.

Mr. Dennis A. Balint discusses Consumer Behavior and Marketing Health.

Since that first program in 1995, both the CWC and the INC have taken an active role in a number of *Oldways* events domestically and abroad. The health studies outlining the beneficial effects of walnuts on cardio vascular risk factors have made walnuts a high profile sponsor of these conferences. The most recent such activity took place in San Diego, California on April 22–23, 2002. As usual, the experience of the *Oldways* staff drew a fine group of researchers and most importantly,

continued on page 14

Worldwide Marketing Staff Meets in San Francisco

From February 19–21 the international marketing staff held their biennial meeting at the Sir Francis Drake Hotel in San Francisco. CWC representatives from Canada, Germany, Israel, Italy, Japan, Korea, Spain and the UK, together with domestic agency, Torme & Co., met to share concepts and ideas which will make marketing efforts more effective in respective countries.

The theme, "Building on our Success", gave the representatives an opportunity to share successes of the past two years and discuss direction for future growth of California walnuts in these markets.

Lan Sohn of Sohn's Market Makers updates the group on the Korean market.

Each agency gave a presentation of their programs for California walnuts in the current year as well as an update of market conditions and future directions.

Three panel discussions were held on topics such as "*The Value of Tie-Ins and How to Negotiate Them*", "*Public Relations - Beyond Health*" and "*Tailoring the Program to the Trade.*" The panels gave everyone an opportunity to get hands-on tools and concepts to improve their programs.

continued on page 14

In this issue...

Production and Post Harvest Research Update

IPM Project Seeks to Expand the PMA's Success with Sprayable Pheromone

Patrick W. Weddle, Senior Consultant,
Center for Agricultural Partnerships

What are the growers best chances for economic success in this day of ever increasing pressures against America's agricultural profitability? How can farmers control costs yet capture the value of new, often more expensive pest management practices and technologies? These were two key questions the **Center for Agricultural Partnerships** (CAP) asked when evaluating the potential for funding and initiating a farm-based project to improve agriculture's economic viability in California while addressing agriculture's environmental impacts. In early 2000, thanks to the highly successful joint efforts of the **Walnut Marketing Board** and the **Walnut Pest Management Alliance** (PMA), CAP identified a significant opportunity to fund, organize and conduct the Walnut Integrated Pest Management Expansion Project. The objectives of the project are simple:

1. To implement a systematic process to enhance the successful adoption of sprayable pheromone-mediated mating disruption technology on a wide scale by commercial walnut growers

2. To measure, document, evaluate and communicate economic, biological, and decision-making changes in the adoption of sprayable mating disruption at the farm, project, and industry levels

Historically, codling moth, a key pest of California walnuts, has been controlled with an array of conventional insecticides. Currently, regulatory pressures including FQPA coupled with resistance to many of the available insecticides have made control of codling moth more difficult and costly. The use of pheromones to control codling moth in pears and apples has become commonplace (e.g. see Figure.1).

The Walnut PMA has demonstrated that many of the techniques for successful pheromone-mediated mating disruption of codling moth, while effective in walnuts, are often economically impractical. With the recent registration of a *sprayable* formulation of codling moth pheromone by **3M-Canada Company** (distributed in California by **Certis USA**) and with pending registration of a sprayable product by **Suterra Ltd.** (Bend, Oregon), walnut growers now have the potential to economically incorporate mating disruption into pest management strategies while reducing the potential negative effects of conventional insecticides on the environment, on worker health and safety and on the beneficial species that suppress other orchard pests.

BUT BEWARE! Mating disruption does not, repeat, DOES NOT kill codling moth. Mating disruption only modifies the behavior of the pest. Mating disruption DOES NOT always prevent mating. But, it can *delay* mating, and that delay can have a powerful negative impact on codling moth populations. A female codling moth that mates late in her life lays fewer eggs. Fewer eggs laid equal fewer worms and less damage. When coupled with effective conventional pesticides, the efficacy of pheromone-mediated mating disruption is further enhanced. If mating disruption technology is carefully implemented, populations of codling moth are reduced to such low levels that very little threat of damage remains and pest control costs are significantly lowered. However, this only works *so long as vigilance in the form of intensive pest monitoring is strictly practiced.*

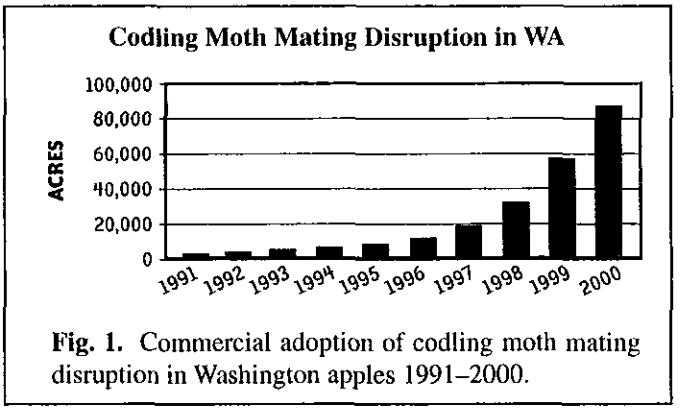


Fig. 1. Commercial adoption of codling moth mating disruption in Washington apples 1991–2000.

Extensive experience in pears and apples throughout the west has shown that monitoring is the key to successful commercial adoption of mating disruption. Unlike conventional pesticides, applying pheromones with insufficient monitoring (i.e. merely assuming that control has been achieved) has led to disastrous results. To ensure that California walnut growers have access to the technology and information needed to successfully implement mating disruption strategies on a commercial scale and avoid the potential pitfalls of this new technology, CAP has established a state-wide network of expert cooperators to assist walnut growers. **Pat Weddle**, a consultant to CAP and a California-based agricultural

consultant specializing in biologically intensive IPM will mange the statewide project. **Steve Sibbett** (UC Cooperative Extension, Emeritus), **Joe Grant** (UC Cooperative Extension) and **Steve Wulfert** (Diamond of California) located in the southern San Joaquin Valley, northern San Joaquin Valley and Sacramento Valley, respectively, will coordinate CAP's activities. These regional coordinators will work closely with well-known walnut pest management consultants in the different regions including **Jim Stewart** and **Judy Stewart-Leslie**, Pest Management Associates, Inc. of Exeter, CA; **Michael Devencenzi** Consulting, Woodbridge, CA and **John Post**, Agricultural Advisors, Inc. of Yuba City, CA. The Center for Agricultural Partnerships is funding this team to work closely with walnut growers to carefully implement sprayable pheromone technology on approximately 1000 acres during 2002. CAP has plans to expand the project acreage to 25,000 acres during subsequent years.

CAP's project cooperators are deploying both pheromone-baited codling moth traps and the new "kairomone lure" baited traps developed and marketed by **Trece, Inc**. Unlike the pheromone lure that attracts males to traps utilizing the same sexual communication chemicals as those used by female moths, the kairomone lure is a host plant volatile that attracts both male and female codling moths independent of any pheromone - mediated sexual communication or mating disruption interference. Because the effectiveness of pheromone-baited traps is reduced in pheromone-disrupted orchards, the kairomone-baited trap has the potential to provide growers and their pest control advisors with an effective tool for monitor codling moth activity in disrupted orchards. Project cooperators will utilize the kairomone-baited traps in conjunction with pheromone traps to learn first hand the effectiveness of this new tool. With on-line web support from **UC-IPM**, cooperators are systematically communicating their trap counts, pest management inputs and experiences with their colleagues across the regions of the CAP project. This "cross-regional" real time information transfer enhances the quality and quantity of learning among project participants. This enhanced learning increases the potential for building confidence in the new technologies being implemented while supporting the successful and economic adoption of those technologies. Because the CAP project works closely with cooperators of long standing commercial involvement in their individual communities, a legacy of commercial adoption is ensured long after project funding has ceased.

Project documentation and evaluation is a cornerstone objective. Not only will CAP evaluate the effectiveness of the target technologies but, more importantly, they will evaluate the impact adoption of those technologies has on cooperating walnut growers' net revenues.

Finally, CAP's methodologies will be employed to assess changes in decision making at the farm level. This understanding provides to project management the knowledge necessary to improve and successfully expand implementation of project objectives in subsequent years.

The Center for Agricultural Partnerships (www.agcenter.org) is a 501(c)(3) nonprofit organization whose mission is to create and implement technology and programs to solve agricultural problems by helping farmers adopt more environmentally sound and profitable practices. CAP's programs improve the productivity and viability of farming operations while improving the well-being of farm communities, reducing pesticide risks, and improving water quality in growing regions across the country.

For further information about the Walnut IPM Expansion Project or The Center for Agricultural Partnerships, please contact Pat Weddle (pweddle@agcenter.org)

Walnut PMA Project Concludes Year 3 with Promising Results for Sprayable Pheromone

The Walnut Pest Management Alliance (PMA) Project has been successful in identifying effective, reduced-risk practices that eliminate or reduce the need for insecticide applications to control codling moth in walnuts. Now in its fourth year, the PMA has validated the efficacy of several mating disruption products including Isomate C+ hand-applied twist tie dispensers and the newly registered, sprayable pheromone product CM Flowable available from Suterra.

At a PMA field day in Chico on November 8, 2001, University of California IPM Advisor Carolyn Pickel said, "Assessing the codling moth population pressure prior to implementation is the key to success with either mating disruption product. In orchards with low population pressure, all pheromones are effective without supplemental control methods."

She advised growers with high codling moth population pressure to use caution during the first year of implementing a mating disruption program, and to supplement with an insecticide application to knock down the population during the first flight. "In the second year, or in orchards with medium population pressure, growers can supplement with a softer insecticide such as Confirm or four applications of the parasitic wasp, *Trichogramma platneri*, aerially applied at the rate of 200,000/acre in August," Pickel said.

It is also recommend that growers using mating disruption continually monitor using pheromone traps, nut drop assessment, canopy counts and a harvest sample. Growers should use pheromon

Justin Hill of Suterra discusses codling moth mating disruption products at a PMA field day in Chico

traps with 1X and 10X lures. The traps with a 1X lure should be hung low in the tree, and the traps with a 10X lure should be hung high in the tree. A new lure, referred to as the DA lure, that uses the scent of ripening pears (kairomone) to attract codling moth instead of codling moth pheromone is commercially available from Trece Inc. The DA lure can replace the 10X high, and it should be hung high in the tree. The PMA plans to conduct outreach to demonstrate how to use the DA lure to evaluate the efficacy of mating disruption.

In the five-acre PMA blocks, Isomate C+ twist ties were hand applied at the rate of 400/acre once shortly after biofix. The sprayable pheromone was applied at the rate of 30 grams of active ingredient (a.i.)/acre, sprayed every 30 days starting just after biofix for a total of five sprays over the course of the season.

The treatments during the fourth year of the PMA will continue to evaluate CM Flowable at varying rates including 30 grams a.i./acre, 20 grams a.i./acre and 10 grams a.i./acre while extending the application interval to 35 days, thus reducing the total number of applications to four. The PMA will also evaluate a sprayable pheromone product developed by 3M applied at the rate of 20 grams a.i./acre at the previously mentioned timing intervals. NufilmP will be added as a surfactant to both of the sprayable pheromone products. Suterra's sprayable pheromone did not get registered in time for growers to try it this year. The 3M non-stabilized formula was registered, but there were limited supplies available.

The PMA has also evaluated the costs of using these alternatives. Isomate C+ can be economically used on small blocks where growers have pruning towers. The cost is $110/acre for the product and an additional $15/acre for application with pruning towers. Sprayable pheromone is expected to be priced at a little less than $2.00 per gram a.i. At the currently recommended rate the cost is $300/acre for the entire season. The data obtained from the treatment blocks at the end of this year, will determine if the amount of active ingredient applied can be reduced and if the timing interval can be extended which could lower this cost considerably and make sprayable pheromone a more economically viable alternative.

The PMA project was designed to evaluate reduced-risk practices using a whole-system approach. Therefore the project is not just focused on reduced-risk alternatives to control codling moth, but is also evaluating reduced-risk practices for controlling other insect pests as well as disease and weeds. In addition, reduced-risk practices are not limited to substituting a softer insecticide for an organophosphate or pyrethroid, but encompass practices like using disease prediction models and modifying cultural practices to reduce risk associated with pesticides.

A disease forecasting model was developed for estimating the risk of walnut blight infections, but in 2000, it had only been validated at one site in Tehama County. During 2001, the PMA conducted validation studies of the model at three blight demonstration sites statewide. The model will provide growers with a tool to help them reduce the number of applications for blight control and is now available to Sacramento Valley growers through Fieldwise.com funded by Griffin LLC. The walnut PMA held three training sessions on using the model to make decisions and how to use the Internet. There are plans for the model to be available to Central Valley growers this year.

The PMA also continues to evaluate the impact of a planted cover crop at the demonstration site in Yuba County. Results have shown that planting a winter annual self-reseeding cover crop helped reduce winter weed problems, and other trials have shown that it has increased water infiltration and decreased run-off.

Damage at Harvest in each orchard and each treatment in the Walnut PMA 2001.

Treatment	Butte	Yuba*	Tehama	Fresno	San Joaquin	Average
Isomate C+ only	0.00	2.40	0.33	0.00	0.2	0.6
Isomate C+ and *T. platneri*	0.20	0.60	ND	0.00	0.0	0.2
Isomate C+ and Confirm	0.00	2.00	0.00	0.00	0.9	0.6
CM-Flowable only	0.40	0.80	0.00	0.00	0.0	0.2
CM-Flowable + Confirm	0.20	0.20	0.00	0.00	1.2	0.3
Confirm	0.00	1.00	0.00	0.00	0.7	0.3
Untreated Check	2.80	0.40	1.33	0.00	4.0	1.7

*Used Lorsban Instead of Confirm

CALIFORNIA WALNUT COMMISSION

FALL REPORT

2002-2003 December 2002

California Walnut Commission Sponsors American Heart Association's Simple Solutions Program

On August 22nd, the CWC and the American Heart Association launched the Simple Solutions program; a free program developed to educate women about how to incorporate simple steps into their lives to reduce their risk for heart disease and stroke.

CWC is thrilled to be working with the American Heart Association on this very important program. By working closely with the AHA, we are reinforcing our health message to consumers. We hope this will encourage consumption as more people become aware of the heath benefits of walnuts and find more reasons to incorporate them into their daily lives.

Heart disease is the number one killer of American women. Stroke is the third leading cause of death. Research shows that less than half of all women are aware of these alarming statistics. But the reality is that 1 in 28 women will die of breast cancer in their lifetime. **One in two** will die from heart disease.

Simple Solutions program spokespeople: Dr. Rose Marie Robertson and Julie Moran.

(Continued on page 3)

Global Health Forum Highlights New Research in Japan

On July 12, 2002, the California Walnut Commission sponsored our first Global Health Forum. The purpose of this forum was to bring together the key researchers in the field of walnuts and cardiovascular health to present their findings to approximately 200 Japanese researchers and health professionals as well as 30 media members.

Dr. Imaizumi presents the newest findings on walnuts.

This forum corresponded with the publication of the newest research on walnuts from Kyushu University in The European Journal of Clinical Nutrition in July 2002. The lead researcher on the study, Dr. Katsuki Imaizumi, was on hand in Tokyo to present his findings. The study shows that adding a handful of walnuts to a cholesterol reducing Japanese diet resulted in a 10.8% percent decrease in LDL (bad) cholesterol in women and an 8.9% decrease in men, completing a pyramid

(Continued on page 7)

In this issue...

WALNUT

PEST MANAGEMENT ALLIANCE

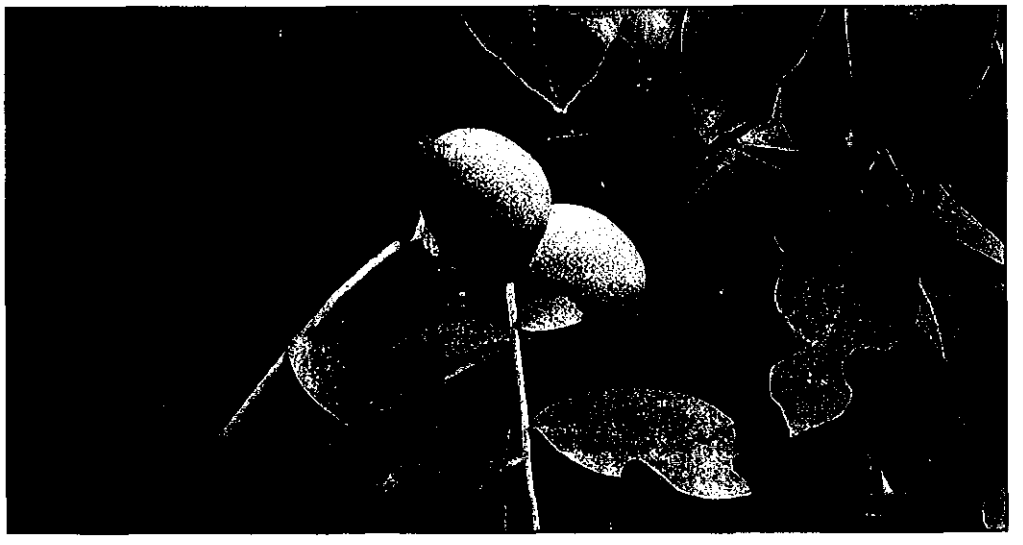
Walnut PMA Notes

Fall 2002

Goal of the Walnut Pest Management Alliance

Bob Elliott, Department of Pesticide Regulation

Given the harsh economics of agriculture, most growers seek innovative ways to stay viable. The Department of Pesticide Regulation (DPR) promotes strategies that lessen the risks to people and the environment while strengthening California agriculture's world leadership. Since 1996, DPR has been immersed in the business of building grassroots support for IPM — integrated pest management — through a wide-ranging grants program. Pest Management Alliances (PMA) are a key element of this program. These alliances are partnerships between DPR and key industry groups with one goal — to identify workable, least-hazardous pest management solutions.



The Walnut PMA is designed to demonstrate reduced-risk practices in grower orchards. Established in 1998 by the Walnut Marketing Board, the PMA is a broadbased implementation project to encourage adoption of a reduced-risk pest management program in walnuts statewide. Since its inception, DPR has provided over $445,000 to establish on-farm demonstration orchards from Redding to Visalia, comparing the growers' conventional program to programs emphasizing reduced-risk alternatives. The primary objectives are to demonstrate IPM strategies to control codling moth and walnut blight.

The true value of the Walnut PMA is the strength of the project management team. With strong industry support and participation by UC farm advisors, IPM advisors, specialists, and researchers, growers, pest control advisors, Community Alliance with Family Farmers, and with liaison by DPR, this group has provided the coordination and communication so necessary for project success. In 2001 the PMA successfully demonstrated the use of an emerging sprayable pheromone technology

See **Alliance** *on page 13*

Who is in the PMA?

Overall management and responsibility for the Walnut PMA is under the direction of the Walnut Marketing Board. Additional participating organizations include UC Cooperative Extension farm advisors and specialists, UC IPM advisors, agricultural experiment station researchers, Community Alliance with Family Farmers (CAFF) BIOS Program, pest control advisors, walnut growers and insectaries.

Want more information about the PMA?

Contact the Walnut Marketing Board
1540 River Park Drive, Suite 203
Sacramento, CA 95815
(916) 922-5888

Walnut PMA Accomplishments

Sara Goldman Smith, IPM Research Assistant

The Walnut PMA, in its four years of existence to date, has field tested the use of pheromone mating disruption in walnuts to reduce pesticide use without an increase in damage to the crop. Some of the most promising methods to release pheromones into a walnut orchard include hand applied Isomate (the industry standard) and sprayables, which can be applied with a traditional orchard sprayer. The PMA has also had encouraging results using multiunit dispensers which have controlled codling moth (CM) with as few as 3.2 dispensers per acre, and aerially applied sprayable pheromone and Isomate ties.

Monitoring of CM with traps is the backbone of a successful pheromone mating disruption program. Pest populations can change from year to year, and traps can give real-time insight into relative numbers of moths and their flight patterns. The Walnut PMA has developed useful monitoring protocols that include directions for trap placement and intervals for checking them. The most reliable method for determining CM population levels is using the canopy count developed by the PMA. The canopy count assesses damage to the nuts on the tree at the beginning of each CM generation. The protocols also contain instructions for the use of pheromone lures as well as information about the new DA lure, which attracts both male and female moths. The Walnut PMA is still learning how to use the DA lure to find out if there is a relationship between catches and damage.

The Walnut PMA again conducted trials to test Xanthocast, the walnut blight model. Each test location had a grower standard block and an untreated check as wel. as a block to verify the blight model. Thanks to support from the Walnut Marketing Board, the researchers and growers were able to access XanthoCast at ***http://wwwfieldwise.com/*** at no cost. To get to the Xanthocast walnut blight index, scroll down and choose 'Text Summary' from the opening page. The Web site was updated daily with the blight risk for each location based on climate data. The Walnut PMA is allowing farm advisors and grower cooperators to learn how to use the model in a practical applied way.

The PMA has been instrumental in serving as a communication body between all groups interested in reducing the reliance of pesticides in walnuts. The Center for Agricultural Partnerships had such confidence in the methodology shown by the Walnut PMA that it began its Walnut Expansion Program early, working directly with PCA's to use sprayable pheromone mating disruption products.

2002 Walnut PMA Harvest Results

Percent Codling Moth Damage at Harvest

Site	Suterra Checkmate @ 10g/ac	Suterra Checkmate @ 20g/ac	Suterra Checkmate @ 30g/ac	3-M Sprayable Pheromone*	Untreated Check	Grower Standard
Yuba 1[1]	1.2	2.1	2.1	1.5	1.2	0.9
Butte[2]	1.3	2.2	1.8	2.2	3.0	2.4
Tehama 1[3]	0.07	0.07	0.07	3.1	0.0	–
SJ 1	1.6	2.5	0.5	1.2	4.7	–
SJ 2	4.7	4.5	5.2	–	8.3	–
Tulare	0.0	0.0	0.0	0.0	0.2	0.0
Average	1.5	1.9	1.6	1.6	2.9	1.1
St. Dev.	1.71	1.69	1.97	1.16	3.19	1.21

* 3-M product rates varied by site (15g/acre – 20g/acre)

[1] Suterra 10g, 20g, and 3-M plots supplemented with Lorsban, 8/15/02

[2] Suterra 10g, 20g, and 3-M plots supplemented with Lorsban, 8/8/02

[3] Suterra 10g and 20g plots supplemented with Confirm, 7/16/02

Lessons Learned in 2002

1. It has been generally believed that pheromone mating disruption reduces pest populations in an orchard over several years. However, in 2002, we learned that that's not always the case. In many plots, the number of CM did decrease, but in several sites that have been in the program for three years, the populations have increased. For example, in 2001, in one of the orchards that was considered low-population for CM increased numbers of moths were trapped and pre-harvest damage indicators from canopy counts went up. As a result, this orchard was supplemented with Lorsban. Previously, Confirm had been used at this location because it was considered to be a low CM population orchard. This shows the importance of continued monitoring in pheromonetreated orchards.

2. Although the mating disruption products are gradually being registered and more commonly used, they are still manufactured on a small scale. In 2002, after all the test plots were designed, it was discovered that there was an inadequate supply of one of the products. The test plots had to be redesigned at the last minute with a lower rate, to make sure all cooperators had enough product for the treatment block. It is important to remember that increased production of these products will come only with increased use by growers. 3. Orchard pest management using pheromone mating disruption may cost more to growers but it may result in improved quality and yield. Th price premium for better quality may pay for the increased cost of integrating pheromone into their pest management program.

Predicting Codling Moth Harvest Infestation in Walnuts

Walt Bentley, IPM Entomologist, Kearney Ag Center

Deciding the need to spray for codling moth in walnuts requires the ability to predict codling moth infestation at harvest. However, just predicting the need for sprays may not be the best approach for codling moth management. The reason, that approach focuses on damage reduction instead of population management. This statement may seem to be one in the same but managing populations implies long-term management. Deciding on in-season sprays is really a short-term strategy, but it can prove to be valuable.

There are three general guidelines to help decide whether damage at harvest will be severe enough to warrant sprays. The first is previous year history of damage. A second is the number of moths trapped (usually based on peaks for each generation). The third method is dropped nuts. A fourth method just beginning to be used by walnut growers is counting infested nuts in the canopy. This technique has been used to predict infestation in apples and pears for years, but not walnuts.

Walt Bentley, IPE Entomologist talks with growers at a Walnut PMA field meeting

Infestation during the previous year is a good indicator of damage potential the following year. Codling moth doesn't go away once it is established in an orchard. There is very little biological control and the insect hibernates in a tough resting stage called diapause. If you had high damage last year and you do nothing to artificially manage the population in the current year you will probably have unacceptable damage again. I define unacceptable damage as three percent or more. An infestation level of five percent will require action to be taken the following year. A first generation supplement spray will be required, even if mating confusion is used.

In my view, trap counts are a poor predictor of harvest damage. There is confusion of where to place traps. Traps placed high in the tree canopy catch more moths than traps placed at head height, but the guidelines for moth catch are based on traps placed at head height. There is also confusion on how often to change lures, what lures or traps to use, and when trap bottoms should be changed. All of these factors influence moth catch, as do weather conditions. Suffice it to say that trap counts are not reliable indicators of a damaging population. These counts are probably a good indicator that populations are not being well-managed and a new approach may be in order. In the past, two moths per trap per night (not week) was a guideline for spraying, however I don't feel confident using that guideline. You should not be catching moths in standard one milligram monitoring traps if mating confusion is being used.

The third commonly used method to estimate harvest infestation is probably the weakest. This is counting dropped nuts. Why is this a poor method? If codling moth attacks the nuts in mid-May instead of late-April, the nuts won't drop from the tree. This situation usually occurs during cool spring weather with delayed moth emergence. If there is a single early peak of moth flight, look for the number of dropped nuts from ten trees approximately six weeks after bloom (mid-to-late-May). Four dropped nuts per tree are of concern. If more than 24 are counted per tree a treatment would be required for the June flight. Nuts counted are those that have evidence of codling moth infestation. Remember, if moth flight is late, finding few dropped nuts does not mean you don't have a problem.

See **Codling Moth** *on page 14*

Pheromone Mating Disruption Options in Walnuts

Joe Grant, UC Farm Advisor, San Joaquin County

Successful use of pheromone mating disruption (PMD) for reducing codling moth damage in apples and pears, along with pressure coming from various sources to find alternatives to organophosphate insecticides, has led to intensive effort to adapt PMD technology in California walnuts.

Though most of the recent focus in PMD research and implementation by the Walnut Pest Management Alliance and others has been on hand applied and, more recently, on sprayable micro-encapsulated formulations, there are also other ways of dispensing pheromones in orchards. This article discusses the pros and cons of different PMD dispensing technologies for controlling codling moth in walnuts.

Before discussing various ways of putting pheromones into orchards, however, several key points about PMD in general should be stressed:

- Researchers, PCAs and growers are still learning how to best implement PMD in walnuts. Growers should keep abreast of ongoing research in order to take advantage of new findings and should work closely with their PCA in deciding where and how to use PMD in walnuts.
- Standard pheromone baited traps do not catch moths in PMD orchards because male codling moths can't locate the traps in pheromone-filled orchards. This means that other ways must be found to accurately monitor codling moth flights and damage potential in PMD orchards.
- The term "mating disruption" is somewhat misleading. Codling moth do mate in PMD orchards, though at a lower rate and later in their developmental life than in conventional blocks. Experience has shown that "trap shut down" (i.e., no moths caught in pheromone traps) does not necessarily mean that PMD is working so well that nut damage will be reduced.
- Growers and PCAs should not limit themselves to viewing PMD as a stand-alone program to be used in place of conventional pesticides. Some orchard situations may be amenable to this approach. On the other hand, effective and economical programs that combine use of PMD and insecticides may be appropriate in other situations.
- To date, no PMD dispensing technology has effectively controlled codling moth in tall trees with high codling moth populations. Success has been good to mixed under other canopy height and codling moth pressure conditions. So growers and their PCAs should exercise care in selecting blocks for PMD.

Hand applied pheromone dispensers are available from several companies. Each company uses a different design, but all are based on a similar concept. A small amount of codling moth pheromone (actually one or three distinct pheromone components, depending on the company) is enclosed in small plastic dispensers that are hung individually near the tops of trees at rates of 200 to 400 dispensers per acre, depending on the product.

The biggest advantage of hand-applied dispensers is that they have been available the longest of all the

PMD technologies and, as such, have the longest track record of grower use, especially in apples and pears. The longest lasting of these products releases pheromone for as long as 150 days. Thus, almost an entire season of control is possible from a single application. Cost of hand-applied products is around $110 per acre at the rate recommended for walnuts.

The biggest disadvantage of hand-applied dispensers is the high cost of labor for applying dispensers, which must be hung individually near the top of walnut tree canopies. This limits use of hand-applied dispensers to orchards with low to moderate canopy

See **Mating Disruption** *on page 14*

Regional Walnut Blight Risk Maps and Five-day Forecasts Are Now On-line

Carla Thomas, Field Wise, Inc.

The XanthoCast work continued this year with documented savings in number of sprays and reduction in observed disease. Reducing the number of sprays was a key benefit to the program this year, since it was a lower pressure year than some other years. Often sprays were not needed, whereas they would have been applied if on a calendar-based spray program. This means a lower cost of production and a better bottom-line, as well as reduced environmental impact.

XanthoCast is the model for walnut blight, developed over a nine-year period by Dr. James Adaskaveg, Department of Plant Pathology, UC Riverside. The model is based on weather conditions and can tell growers if the environment is favorable for walnut blight infections. If the environment is favorable, and the crop is at a susceptible stage (catkins or young nuts present) then it is appropriate to spray for walnut blight. Otherwise, it is not necessary to spray. Dr. Adaskaveg's work to develop this model was funded by the Walnut Marketing Board.

In 2001, a pilot program posted colored maps of the XanthoCast index for the Sacramento Valley as measured at 52 locations throughout the region. Red areas showed high risk, green areas showed low risk and yellow areas showed moderate risk levels. The model performed well with a number of growers indicating to us that they reduced the number of sprays in their orchards, while maintaining a clean crop.

In 2002, the program was expanded to include a XanthoCast risk map of the Stockton-Lodi area using weather station data that was provided by Western Farm Service. Both the Sacramento Valley and Stockton-Lodi maps are available on the Internet. They are updated every day from April through October. They are provided at no charge to the growers by industry sponsorship.

XanthoCast five-day forecasts are a new product that became available on the internet in 2002. These forecasts gave the expected XanthoCast index for the next five days. They are posted every day, and are meant to complement the current conditions shown in the XanthoCast Risk Maps.

Growers found these forecasts to be helpful in scheduling spray operations ahead of time, so that the crop is covered before the disease event occurred. Farms with large acreage found that this made it easier to use the model, since it gave them five days to get the large acreage covered before an infection event. Then they could refer to the current conditions from the XanthoCast Risk Map to verify that the forecasted conditions actually occurred.

The Walnut Marketing Board funded the development of the XanthoCast index in 2001, which was developed collaboratively between Dr. James Adaskaveg of UC Riverside, Field Wise, Inc. and Fox Weather, LLC. The forecasts were usually 60 to 90 percent accurate, depending on the weather station location and whether it was one or five days in advance of an event.

Site specific subscriptions give growers detailed information, including the site history throughout the season and real-time weather conditions. Subscription services may also include soil moisture monitoring and evapotranspiration values for irrigation scheduling.

The XanthoCast Risk Maps and five-day forecasts can be viewed at no charge at ***www.fieldwise.com*** or ***www.westernfarmservice.com*** and ***www.agdecision.net.***

Alliance *from page 9*

for controlling codling moth, demonstrated the use of a new and improved monitoring lure, and field-tested walnut bud sampling methods, eradicant sprays, and a forecasting model (Xanthocast) for blight control. In 2002, increased emphasis was placed on use of reduced rates of sprayable pheromone to reduce overall input costs. In a parallel project by the Center for Agricultural Partnerships, pest control advisers were recruited to help refine monitoring techniques for codling moth, and to use sprayable pheromones as the primary program in commercial orchards. Based on preliminary results additional work will be conducted in 2003.

The long-term goal of a fully implemented Walnut PMA would be to reduce organophosphate (OP) and pyrethroid insecticide use by 75 percent on the 100,00(acres of codling moth susceptible varieties. A short-terry goal is to convert 25 percent of the state's walnut acreage from use of conventional insecticides to sprayable pheromone by 2003.

For more information about DPR's Pest Management Grants Program contact Bob Elliott, DPR Grants Administrator, at (916) 324-4100 or ***belliott@cdpr.ca.gov.***

Codling Moth *continued from page 11*

The Walnut PMA has relied on canopy count, or counting infested nuts within the canopy. There is a direct relationship between damaged nuts in the canopy found in June (after the first flight) and in mid-July (after the second flight) and damage at harvest. Those using this technique need not look at nuts in the upper half of the tree. Infested nuts from the lower canopy can be counted for an estimate of damage. The Walnut PMA research has shown no difference in infestation high or low in the tree. This is confusing because more moths are caught in pheromone traps placed high in the tree. The explanation is that traps are more efficient (easily found by males) high in the tree. Egg laying by females occurs throughout the canopy.

To conduct a canopy count, examine 50 nuts from at least 10 trees per block. If the canopy is low enough, examine the nut while it remains on the tree. Where the lower canopy is above eight feet, use a pruning pole to remove the nuts for examination. As with the dropped nut counts, look for evidence of codling moth feeding. If two or more nuts are found per 100 sampled, a problem exists. The canopy count in June is most important. Infestation at that time can be dealt with easily. Counts can also be made in late July, after the third flight and the relationship is as accurate as the June flight. However, there is less time to remedy the problem before harvest. If infested nuts remain on the tree during June and July, be aware that navel orangeworm will develop in them. Early harvest is then a priority.

The trick in predicting harvest infestation is accuracy. The methods that are most accurate are previous years history of codling moth infestation and June and July canopy counts. Moth abundance in traps and dropped nut counts are supporting methods.

Mating Disruption *continued from page 12*

heights (20-25'). Application costs ranged from $15 to as high as $90 per acre per application in hand applied dispenser tests in San Joaquin County. Research is underway to evaluate ways of reducing this cost, including applying dispensers with an airplane and clustering dispensers in scattered trees throughout the orchard. These approaches show promise but need further testing and are not available commercially.

Pheromone micro sprayers or "puffers" are another alternative for dispensing pheromones into orchards. Puffers combine an aerosol can containing a full season's worth of pheromone with simple electronic controls and a valve/nozzle assembly in a small plastic enclosure. These are hung in trees at rates of one to three per acre. One company currently markets codling moth puffers in California.

Early research with prototype puffer designs gave mixed results in walnuts. But recent mechanical improvements and research into their proper deployment in orchards have vastly improved the prospect that puffers may prove to be an effective PMD alternative in walnuts. At a current cost of $100 per unit for pheromone and dispenser, they are cost-competitive with other dispensing technologies and with conventional programs, especially at rates as low as one unit per two or three acres currently considered feasible in walnuts. One disadvantage of puffers is that areas between puffers along the windward edge of orchards may not retain enough pheromone to disrupt mating, thus necessitating supplemental treatment of orchard perimeters with insecticides or sprayable pheromones. Puffers also dispense so much pheromone that pheromone trap captures in blocks downwind of PMD-treated blocks may be reduced, thus complicating control decisions in those blocks. Regular monitoring and maintenance of puffers is required during the season to ensure they are working properly.

Micro-encapsulated sprayable formulations have been the focus of most of the PMD work. Two companies have sprayable codling moth formulations registered for use in California walnuts. Compatible with a wide variety of other spray materials, sprayable pheromones offer the advantage of easy application using conventional orchard equipment. The thorough coverage of leaf and nut surfaces needed for conventional insecticides is not necessary for pheromones, though it is still important that sprayable pheromone applications reach to the tops of tree canopies. The biggest drawbacks of currently available sprayable formulations are their high price and their limited residual activity in orchards. At current recommended rates and prices, material cost of these products is roughly $40 per acre per application. Three or four applications are needed for season long suppression. Research and grower testing are underway to find cost-effective ways of integrating sprayables into walnut pest management programs.

Work on adapting PMD in walnuts will continue, within the Walnut Pest Management Alliance as well as other projects. Growers, PCAs, and researchers involved in this work are optimistic that this technology will prove to be an effective and affordable tool for managing codling moth in walnuts.